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Natural gas-based petrochemicals
Methanol the best of bad lot
A Key Chemicals Review Page 23
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Cover: Getty Oil's $110 million, 100 million gal-per-year methanol plant at Delaware City, Del., due for completion in first-quarter 1983

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CHEMICAL & ENGINEERING
NEWS
JANUARY 24, 1983

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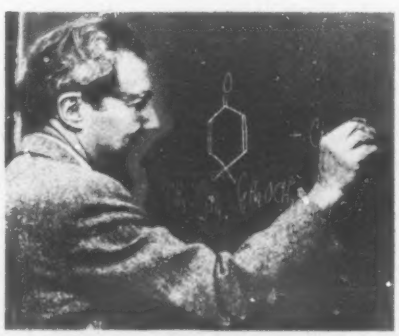


News Focus

Harvard's Frank H. Westheimer reflects on his 1965 report and details views on the current state of chemistry. **Page 14**

Outlook Mixed for Natural Gas-Based Petrochemicals

Methanol will be helped by fuel uses, formaldehyde by housing recovery; but ammonia and urea will be hurt by agricultural woes

Bruce F. Greek, C&EN Houston

Basic U.S. chemicals produced starting with reforming natural gas are developing divergent fortunes as 1983 opens. Prospects are that this new divergence could continue throughout much of this decade. Those containing nitrogen—ammonia and urea—could face lower production for some time. By contrast, the outlook for the other two—methanol and formaldehyde—may brighten as a result of new demand.

But all of these small-molecule petrochemicals face major problems in competition from foreign sources. They are headed for the same combination of increased imports and decreased exports expected for many other large-volume U.S. chemicals.

Because of the decline in farming income in most parts of the world, ammonia and urea demand decreased radically in both U.S. and foreign markets for U.S. producers during 1982. The decline appears to be carrying over into 1983, but at a slower rate. A turnaround in demand might occur in 1984, but the variables of weather, politics, and economics make long-term forecasts risky.

Production of methanol and formaldehyde also declined quite rapidly during 1982. Fortunately, the new fuel uses of methanol are growing—admittedly at least a year later than by most forecasts—and are expected to give a good boost to 1983 demand. Later on, fuels will continue to be a fast-growing use of methanol. U.S. production to meet demand in fuel use might be tempered, however, by a rising tide of imported methanol from countries such as Canada and Saudi Arabia with lower-cost natural gas.

The impact on these four major C_1-petrochemicals from the 1982 slump was in line with the general drop in output of chemical commodities. Production declines ranged from 13 to 17%. Prices fell sharply, too, and production value nose dived.

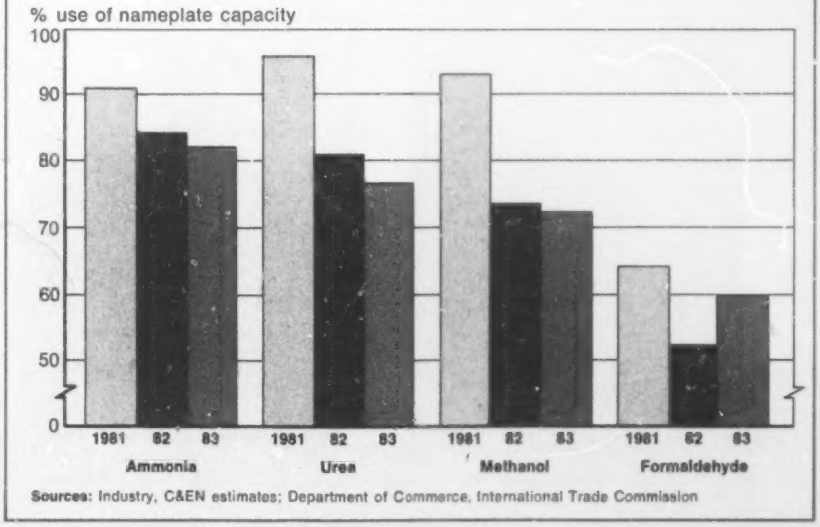
Combined production volume dropped 15% in 1982 to 57.7 billion lb for the four chemicals (including the water content of formaldehyde solutions). Another slight combined drop looks likely for 1983, bringing the total optimistically to just under 57 billion lb.

The substantial drop in production value for these petrochemicals may not yet be quite over. Current industry estimates of production value for these four products for 1982 now total $4.2 billion, off 16% from 1981. Another $200 million could come off in 1983 unless prices and demand exceed present expectations. Hence, the net drop in value for 1983 will be about 20% from 1981, unadjusted for inflation. Ammonia and urea will account for 90% of this decline.

Key Chemicals

Although prospects for production increases beyond 1983 might be fairly good, prospects for price increases are dimmed by potential import competition. Currently, industry complaints about low-cost ammonia coming in from Mexico are being considered by the Commerce Department. Many in the ammonia industry believe that resolution of these complaints, even if favorable to U.S. ammonia producers, may come so late this spring that U.S. plants

Capacity use this year will stay low



Sources: Industry, C&EN estimates; Department of Commerce, International Trade Commission

now shut down won't be restarted in time to sell much production during the big spring market surge.

For the longer term, continued low-priced imports of ammonia and loss of export markets for ammonia, urea, and other ammonia derivatives likely will bring more decline in U.S. ammonia production. The exception would be if U.S. farmers increased application rates for fertilizers and planted larger acreage. But neither of these possibilities seems likely to help U.S. ammonia producers for the rest of the 1980s.

One result is growing concern by various analysts of ammonia and the agricultural industry about U.S. dependence on foreign sources of fertilizer nitrogen. One alarmist viewpoint holds that a temporary shortage of ammonia at the planting season could take away a large part of a year's crop.

Similarly, longer-term imports of methanol could hurt expansion of U.S. methanol capacity. Although at the moment a big addition to U.S. capacity is being completed, little more seems likely until much later in this decade.

Much of this U.S. capacity expansion in methanol is aimed at the automotive fuels market. Industry analysts expect gasoline to continue to be a growing blending market for methanol itself and for methanol derivatives such as methyl *tert*-butyl ether (MTBE). These uses aim at gaining the octane value of methanol for upgrading the octane value of unleaded gasoline.

There is controversy, however, on the subject of methanol and derivatives in gasoline. On the one hand, increased octane value is a plus. For some time these materials have been a less-expensive way to gain octane than by using additional quantities of competing aromatics such as toluene.

On the other hand, possible disadvantages with methanol and derivatives start with corrosive effects on auto fuel systems and gasoline handling systems. Add to this the lower heat value of methanol compared to gasoline. In addition, some drivability problems have cropped up because gasoline-methanol blends have unusual changes in vapor pressure.

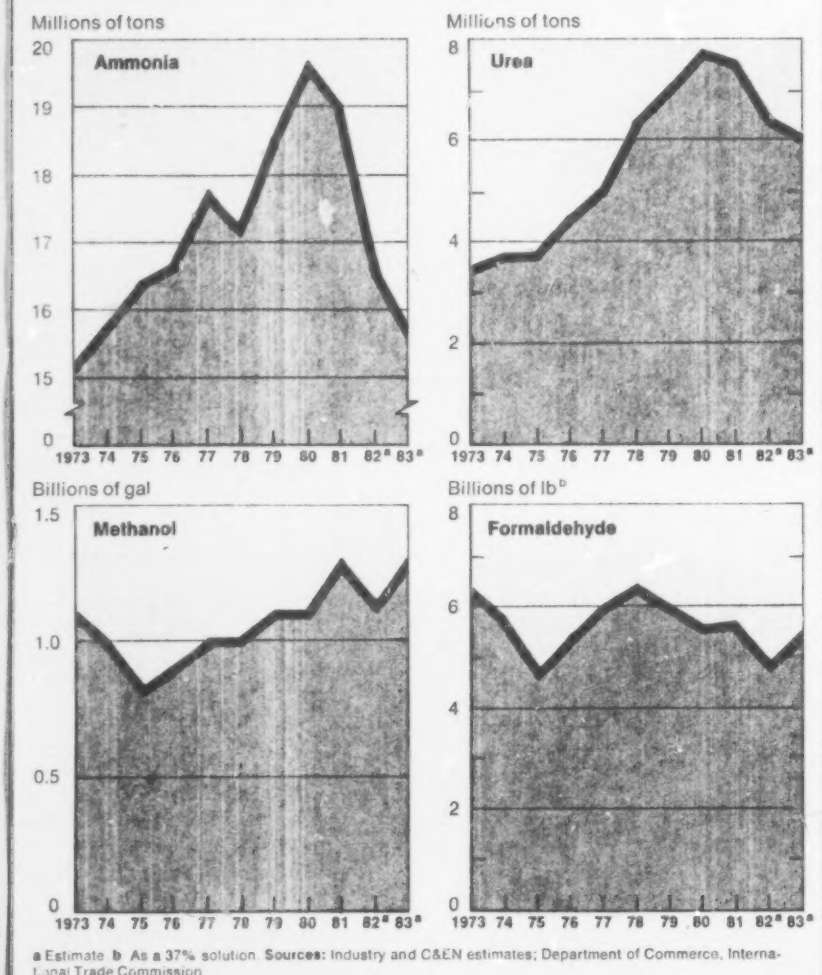
Disagreement over these factors leads to divergent views on the volume of methanol that will go into fuels over the longer term. Few analysts doubt a surge in fuel use of methanol or derivatives in 1983 from a small base. The pickup might continue at lower rates for several years until surplus U.S. methanol capacity and low-cost import volumes are used up. By then, some analysts speculate that fuels uses easily could exceed formaldehyde as the largest single methanol market.

At this point, even if for some reason use of methanol and derivatives in gasoline should slump, optimists forecast that methanol could be used in power plants—especially imported methanol made as an alternative way of shipping natural gas and as a way of gaining hard currencies. In power generation, methanol would have special advantages such as no sulfur combustion products and adaptability to peak shaving needs.

Pessimists, by contrast, claim that corrosion, handling, and auto drivability problems may make methanol fall out of favor in fuels as quickly as it came in. Unknowns yet to be explored are longer-term effects of methanol on the reinforced plastic tanks gaining use for storage at gasoline outlets. There also is the question of leaks. These concerns may delay government waivers on greater use of methanol in gasoline.

For the near-term outlook for these four C_1-petrochemicals, please see the following pages.

1982 recession hurt production of all four petrochemicals



a Estimate b As a 37% solution **Sources:** Industry and C&EN estimates; Department of Commerce, International Trade Commission

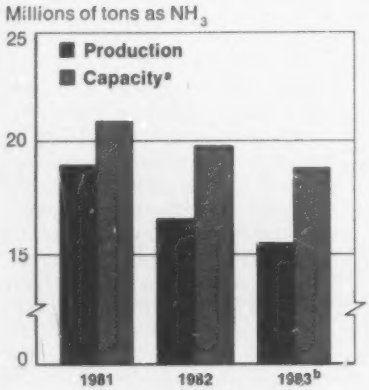
Key Chemicals

NH_3

Ammonia

- ***Production falling***
- ***Some capacity closing***
- ***Prices low, holding***

PRODUCTION/CAPACITY



a First quarter. b Capacity includes more than 4 million tons shut down, some of it permanently.

HOW MADE

Catalytic reaction of nitrogen from air and hydrogen from natural gas

MAJOR DERIVATIVES (U.S.)

Nitric acid 20%, urea 20%, ammonium phosphate 15%

MAJOR END USES (U.S.)

Fertilizer 80%, fibers and plastics 10%, explosives 5%

FOREIGN TRADE

Exports—might reach 1 million tons in 1983, imports—could rise to nearly 2.5 million tons in 1983

PRICES

$115 to $125 a ton on Gulf Coast

COMMERCIAL VALUE

$2 billion for production, 1983

U.S. ammonia producers continue to be burdened by a multitude of problems. They face higher raw material natural gas costs, other production and transportation cost increases, growing competition from lower-cost ammonia from foreign countries, loss of some of their final customers, and decreasing ability of most of their remaining customers to buy as much fertilizer as in the past.

So producers still are doing what they have done over the past few years—shutting down plants. In general, producers who continue to operate sell on a "cash-cost" basis, by which price covers only producers' direct cash operating costs. Most producers apparently have a negative cash flow.

In the current crop year ending June 30, farm commodity prices have continued their drop in real value with a possible slight acceleration. Prospects for increased commodity prices wax and wane with government proposals to help farmers. For ammonia, and fertilizers generally, these commodity prices largely will tell the near-term prospects for production and sales.

This means that, for calendar year 1983, production forecasts for ammonia are not bright. Predictions range from 15 million to 16 million tons of ammonia, down perhaps 1 million from an estimated 16.5 million tons for 1982. This decline will follow an even larger decline of 1.5 million tons in 1982 from just over 19 million tons in 1981.

Beset by greater costs and competition from imports, ammonia producers have been shutting down plants at about the same pace as the output decline. Because of these shutdowns, estimates of nameplate capacity for ammonia are called suspect by more and more industry analysts. Actual scrappage announcements seem to be coming faster now, suggesting that more and more producers will strike shutdown ammonia capacity from the list of potential restarts.

About 1 million tons per year of ammonia capacity has been scrapped or permanently shut down during the past two years. Currently, more than 4 million tons of capacity is shut down. Some industry sources believe that half of this capacity will not be restarted. Most sources expect that at least 1 million more tons of capacity will be taken permanently from the list in 1983.

With this pace of shutdowns following production cuts, nameplate capacity use remains relatively high for ammonia compared to many other large-volume chemicals. This has been the case for a long time. It is a characteristic of the industry and an important clue to how producers manage costs.

Even now, capacity in operation is far below the most pessimistic forecasts for 1983 production of ammonia. Nameplate capacity of ammonia plants operating in early January totals about 14.75 million tons per year. Few expect 1983 production to be less than 15 million tons. Clearly, some capacity will have to restart soon. And a possibility exists of spot shortages this spring during planting season.

Any shortages could help ammonia producers by pushing up prices during the high-demand season. Price could increase 30 to 50% some time this spring from the present range of $115 to $125 per ton. The increases might last longer, if foreign sources prove more unreliable than they already have been.

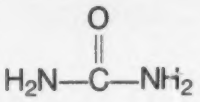
However, higher prices naturally would spur foreign producers to get plants back on stream as quickly as possible or to ship from inventory previously reserved for internal use. After the end of the high U.S. demand season and a rush of imports, higher U.S. ammonia prices might not last long enough to help U.S. producer finances significantly in 1983. In this event, shutdowns simply would continue.

Because most ammonia is made into derivatives, and large amounts of these derivatives—particularly ammonium phosphates and urea—are exported, the actual end-use breakdowns become blurred. Another complicating factor is that considerable ammonia is imported and converted to derivatives. Derivatives with agriculturally useful nitrogen are then re-exported. Until 1981, the U.S. had had a net nitrogen export balance for several years. A flip-flop since then has made the U.S. an unwilling net importer.

Overall, unless unexpected changes occur in farm prices and exports in 1983, the year will go down as one of the worst for ammonia in many years.

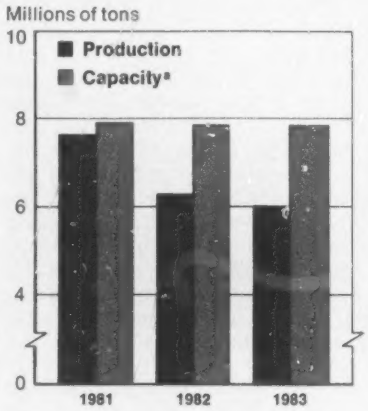
Key Chemicals

Urea



- ***Production falling***
- ***Capacity down***
- ***Prices weak***

PRODUCTION/CAPACITY



[a] First quarter.

HOW MADE

Reaction of ammonia and carbon dioxide under pressure

MAJOR DERIVATIVES (U.S.)

Urea-formaldehyde resins 5%

MAJOR END USES (U.S.)

Fertilizer 80%, adhesives and plastics 10%, animal feed 5%

FOREIGN TRADE

Exports—declining to about 1.25 million tons in 1983, imports—holding at about 1 million tons in 1983

PRICES

$120 to $125 a ton on Gulf Coast

COMMERICAL VALUE

$800 million for production, 1983

Urea and ammonia frequently come from the same producer, and the two products share similar problems. Whereas fertilizer is the dominant use of urea, ammonia's ills in the fertilizer industry also are those of urea.

Production of urea continues to fall, and a number of plants are now shut down. Because of the many nonproduction influences on urea demand, such as weather and exports, estimates of production early in any year range widely. For 1983 the spread of estimates is wider than usual; they center on 1983 production of 6 million tons. The range, however, goes from less than 5 million tons all the way to 7 million tons.

More than in almost any other large-volume chemical, pessimists and optimists' views clash for urea. Part of the problem comes from difficulties in getting good overall statistics. For example, industrial uses of urea often are ignored by agricultural analysts. Export data come in slowly, too. U.S. government production data are considered relatively imprecise, generally too high.

Less murky are the underlying reasons for a weak year for urea. They are mostly those common to the whole fertilizer industry. Farm commodity prices, farmers' debt levels, and related woes will influence urea demand this year very unfavorably. Exports are expected down too, because of the same factors in other countries plus increasing competition in export markets from urea produced in other countries, especially Eastern Europe.

These negatives help set up the more sour view for urea this year. According to the pessimists, even with sizable reductions in U.S. urea inventories this past fall, production this spring will go only to meet immediate demand, even at the risk of spot shortages and possible lost sales. Demand this spring then will provide producers a pattern for production next fall. If spring demand is weak and suggests little need to build inventories in the fall, 1983 production could come in at a mere 5 million tons.

Optimists demur. They say that good weather, better farm commodity prices as a result of acreage set-asides, and export demand improvement will combine to make a better year for urea in 1983 than in 1982. Their forecast production level of 6.5 million to 7 million tons of urea in 1983 will be up as much as 11% from an estimated 6.3 million tons in 1982.

Plant capacity for urea apparently has undergone no scrappage. This is not to say that large amounts of the capacity remain idle. As the year turned, at least as high a fraction of urea capacity was shut down as in ammonia, more than 20%.

Urea producers differ a bit from ammonia producers in that if they have a raw material carbon dioxide supply, they can continue to operate by purchasing ammonia. Some are believed to be doing this now because of the low ammonia prices. This opportunity could account for producers hanging on to their shut-down plants rather than scrapping them.

Hence, given urea's large shut-down capacity and questions about how much of it will run again, the estimated operating rate for nameplant capacity can cover a wide range. For 1983, the rate could range from 65 to 90%. A middle estimate would be 77%, below the level of ammonia plants.

Similar to ammonia, no significant new capacity for urea will be coming in the U.S. for some time. Prices, now about $120 per ton on the Gulf Coast, could be giving a negative cash flow to producers that are still running, unless their ammonia costs are very low.

As is the case with ammonia, imports of urea are rising from nothing in past years to substantial quantities from countries such as East Germany and Qatar. These imports aim to take advantage of factors such as the strong dollar.

The nonagricultural uses of urea are not helping overall production either. Resins outlets, urea-formaldehyde and melamine, have been hit by the housing slump. Even a sharp recovery in housing this year will not be enough to do very much for urea as a whole because these resins account for less than 10% of U.S. urea use.

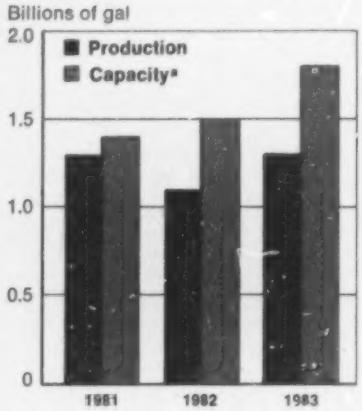
Hence for 1983, urea will ride uncomfortably with fertilizers' fortunes in both the U.S. and abroad. Although many variables could change demand from forecasts, hope for a better year than 1982 at the moment seems quite dim.

Methanol

CH_3OH

- ***Demand to rise***
- ***Capacity way up***
- ***Prices discounted***

PRODUCTION/CAPACITY



a First quarter.

HOW MADE

Reaction of carbon monoxide with hydrogen made by reforming natural gas or heavier hydrocarbon fractions

MAJOR DERIVATIVES (U.S.)

Formaldehyde 30%, acetic acid 10%

MAJOR END USES (U.S.)

Polymers uses as adhesives, fibers, and plastics 50%, solvents 10%

FOREIGN TRADE

Exports—holding at about 100 million gal in 1983, imports—rising to about 100 million gal in 1983

PRICES

List prices 72 cents a gal and higher; discounting significant

COMMERCIAL VALUE

$750 million for production, 1983

Methanol has become one of the few major-volume U.S. chemicals with a new, fast-growing use—fuels. This outlet, considered by most in the business as nonchemical, probably will help spur production in 1983 to at least the level of 1981, or some 1.3 billion gal. It also is sparking a part of the major U.S. methanol capacity either just started up or expected on stream later this quarter.

Such a production increase of more than 15% in 1983 for methanol will come from several pressures. Obviously, one is to build an operating inventory for producers who are adding capacity. Another, the largest, will be the growing fuel market, which easily could take more than 100 million gal in 1983, accounting for about half of the overall expected production growth. Old-line uses such as making formaldehyde also are expected to recover as some improvement takes place in housing and other construction. And a newer use, making acetic acid, also is expected to add to demand in 1983.

The possibilities are strong, according to some industry hopefuls, for an even better 1983 than this for methanol. These optimists say that production could top 1.4 billion gal, because fuels' uses of methanol could reach 150 million to 200 million gal. Other methanol uses, they say, are about the same as in more conservative forecasts.

There are several fuel uses of methanol. For some time now, the gasoline additive methyl *tert*-butyl ether (MTBE), the product of a reaction of methanol and isobutylene, has required significant quantities of methanol as its use grows as an octane booster for unleaded gasoline. More recently, a blend of methanol and *tert*-butyl alcohol, sold by Atlantic Richfield as Oxinol, has been added to gasoline, also as an octane-value additive. In the future, straight (neat) methanol might be added to gasoline if the Environmental Protection Agency approves a petition by Du Pont to allow methanol to be blended into unleaded gasoline in quantities up to 3%.

Currently, only 0.3% methanol can be added to gasoline. This small amount has been allowed to take up any water in gasoline to reduce icing problems in cold weather.

If methanol were added to gasoline above 3%, or possibly 5%, enough water pickup would occur to cause a phasing out of a methanol-water layer, according to industry sources. When such a separation does occur, corrosion problems develop fast. To overcome this problem, a low-cost and effective cosolvent—*tert*-butyl alcohol, for example—is used.

The long-term fuel potential for methanol looms far beyond current plant capacity. If U.S. annual gasoline consumption is 80 billion gal, and half of that is unleaded (both conservative estimates), and 1% methanol is added in one form or another, this annual methanol use would total 400 million gal. At 4%, the fuel demand could exceed present U.S. nameplate capacity to make methanol.

Some U.S. refineries of crude oil apparently have made this connection, because they account for most of the methanol capacity expansion coming on stream now. Arco Chemical has just started up its new unit at Channelview, Tex., adding 200 million gal per year of capacity, and Getty Refining shortly will add 100 million gal of capacity at Delaware City, Del.

These expansions and other smaller capacity additions from 1982 will bring U.S. nameplate capacity for methanol to 1.8 billion gal for most of 1983. If production of methanol reaches 1.3 billion gal, plants will need an average operating rate of about 73%. If the more hopeful industry analysts prove right, the rate could reach 76%.

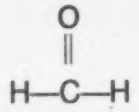
Next to fuel, the fastest growing use of methanol is in making acetic acid. Here, methanol is in effect a replacement for ethylene. Although rapid growth slows as the base gets larger, this year acetic acid manufacture likely will take about 10% of methanol production.

Formaldehyde will hold first place as a use of methanol for some time to come. It was hit hard in 1982 because of the decline in demand for adhesives in making plywood and in making polymers for components for cars and appliances. In 1983, demand for formaldehyde could recover almost to 1981 levels, pulling methanol along.

So 1983 will be a better year for methanol. Fuel uses may grow enough to hold up plant operating rates even as capacity expands some 20%.

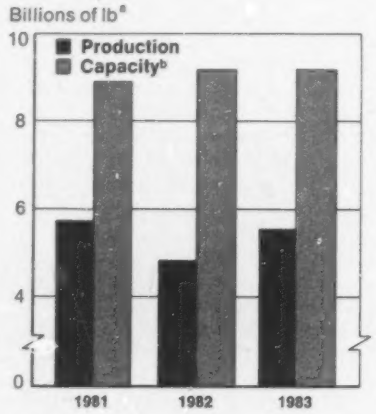
Key Chemicals

Formaldehyde



- ***Demand to pick up***
- ***Capacity flat***
- ***Prices weak***

PRODUCTION/CAPACITY



a As a 37% solution. b First quarter.

HOW MADE

Catalytic oxidation of methanol

MAJOR DERIVATIVES

Urea-formaldehyde resins 30%, phenol-formaldehyde resins 20%

MAJOR END USES

Adhesives 60%, plastics 15%

FOREIGN TRADE

Exports—small, possibly 25 million lb in 1983, imports—negligible

PRICES

List prices—about 9 cents per lb for 37% solution; merchant volume small, with prices discounted

COMMERICAL VALUE

$500 million for production, 1983

Formaldehyde continues to struggle with bad fortune made up of two parts. The concern over carcinogenesis hasn't been laid to rest, even though some studies indicate no notable effect on workers and even though the government banned urea-formaldehyde foam insulation in homes and schools. Add to this the shock of the 1982 recession in housing, which probably dropped formaldehyde production 16% in 1982.

Seasonality of demand for formaldehyde makes estimates of 1982 production somewhat uncertain, but output probably totaled 4.8 billion lb of 37% solution. This was down at least 1 billion lb from initial estimates for the year, which assumed a good fourth quarter in housing. If the more dour industry opinion proves accurate for the fourth quarter, 1982 production might have been off even more, possibly 4.6 billion to 4.7 billion lb.

Despite its current pickup, the housing industry doesn't inspire all formaldehyde industry sources for 1983. Some say that the pickup in housing and commercial construction is still weak and will not be much better later on this year. Hence, the middle estimate of 5.5 billion lb of 37% solution formaldehyde production for 1983 could be high by 5%, according to the pessimists.

But other analysts see a better year. They say that 1983 production will match 1981 at about 5.7 billion lb. The optimists lay the roughly 1-billion-lb production increase in 1983, or 20% precisely, to an anticipated surge in housing starts. One part of this will be a unit volume increase, which will carry along with it increased demand for plywood and particle board using formaldehyde-based adhesives. Another part will be the need for more inventories of these adhesive materials following an upswing in demand. And a third part could be a shift to relatively more use of plywood and particle board as a cost-saving effort to further spur housing.

Whatever the final outcome in 1983 for formaldehyde, an increase in production would push producers' plant operating rates to between 58 and 62% of nameplate capacity. Although not as good as rates for many other major-volume organic chemicals, these percentages will be well above the 1982 range of 50 to 52%. Clearly, during 1982, many formaldehyde plants have been shut down for varying periods of time. Such plants are closely tied to plants making resins for plywood and particle board. Many of these formaldehyde plants are relatively small, and a shutdown and startup costs little.

Which plants are shut down and kept down may hinge on the outcome of efforts to set standards for formaldehyde emissions. For 1983, most industry sources expect little impact if standards are finally set—probably late in the year if at all. In any case, after 1983, standards and concern over emissions could have a big impact on the plywood-particle board use of formaldehyde, which accounts for half of all formaldehyde production.

Besides resins used mainly as adhesives, formaldehyde goes into many other derivatives, many of which also are resins. None of these other uses is nearly as large as the urea- and phenol-formaldehyde resins. None except for some very small volume specialties is expected to grow at rates much above those of the adhesive resins.

Polyacetal resins, for example, are expected to aid recovery of formaldehyde production during 1983 because these resins go into various small parts. They are among the faster growing uses of formaldehyde over the long term.

Butanediol competes with the polyacetal resins as a more rapidly growing use of formaldehyde. This specialty intermediate goes into a variety of uses such as thermoplastic polyester, polyurethanes, and solvents. One of the bigger uses also hit by the housing decline is manufacture of tetrahydrofuran, a solvent for the cements used in joining polyvinyl chloride pipe.

Somewhere between 15 and 20% of formaldehyde is consumed by miscellaneous uses—the third largest category after urea- and phenol-formaldehyde resins. Although some of these are sizable—but not 5% of the total—none has volume or growth rates large enough to change formaldehyde's outlook for several years.

For 1983 then, formaldehyde's fortunes remain tied to its big uses. A good recovery in housing, if not a boom, could bring formaldehyde production back to about 1981 levels.